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THE BANANA: A FOOD OF EXCEPTIONAL VALUE

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THE banana of commerce is the fruit of various species of *Musa*, a plant which develops abundantly throughout the whole tropical zone. Many species of *Musa* are known, differing in size and character, and their fruits likewise show differences in size, appearance and flavor. Various common names are given to the different varieties, such as red bananas, yellow bananas, apple banana, date banana, ladyfinger, etc. The banana found principally in the American market is the fruit of the *Musa sapientum*, of which there are a large number of varieties, the most common being the Gros Michel banana. The plants and their fruits differ considerably in appearance and actual composition, according to the environmental conditions of soil, climate and other geographical and geological features.

The banana constitutes the chief carbohydrate food, in fact the principal food of enormous numbers of people in many parts of the tropics, thus taking the place of cereals and tubers, such as wheat, rye, barley and potatoes, in the food relations of the temperate zone. Careful computations have been made by numerous authors showing that the actual amount of food material produced per acre in the cultivation of bananas exceeds that of wheat or any other crop. The banana is therefore to be considered not as a luxury but as a very important staple in the food supply of the world. From this point of view it deserves much higher consideration than it has hitherto been accorded.

Since the edible portion is surrounded by a thick enveloping skin it is effectively protected against the attacks of bacteria, moulds and other agencies of decomposition, therefore if the skin is unbroken it may always be eaten with the assurance of its sanitary quality and freedom from dirt or objectionable material.

THE COMPOSITION OF THE BANANA

Many analyses of the banana have been made by different investigators. Since we are especially interested in the American banana, it is probable that the average of the American analyses may best be quoted: Atwater and Bryant, working under the auspices of the U. S. Department of Agriculture, give the following figures, showing the analysis of the edible portion of the banana, U. S. Dept. of Agriculture, Bull. No. 28, revised edition, 1906, p. 71:

	Water, Per Cent.	Protein, Per Cent.	Fat
Minimum	66.3	1.0	.0
Maximum	81.6	1.6	1.4
Average	75.3	1.3	.6

	Total carbohydrate, Per Cent.	Ash, Per Cent.	Fuel value per lb.
Minimum	16.3	.5	330
Maximum	29.8	1.1	640
Average	22.0	.8	460

The banana as purchased contains, of course, a large amount of inedible material, the skin, which amounts approximately to 35 per cent. of the total weight. Since, however, bananas are ordinarily not purchased by weight, but by number, this does not enter into the general question of either cost or food value. The ash of the banana is principally made up of the phosphates, sulphates and chlorides of potash, soda, magnesia and lime, all of which serve useful purposes in the body economy. It is thus seen that the banana contains all the classes of food materials required for the animal body, although the amount of protein and fat are too low in proportion to the carbohydrate to constitute a perfectly balanced ration. The combination of banana with milk in proper proportion, or its utilization as a vegetable to supplement a diet containing a small amount of meat will produce a ration which is ample to take care of the body needs.

COMPARISON OF BANANA AND POTATO AND OTHER FOODS

A comparison of the banana with the potato is of particular interest. Again quoting from the carefully made tables of Atwater and Bryant, page 68 of Bull. No. 28, above mentioned, we have the following figures:

	Potato, Per Cent.	Banana, Per Cent.
Water	78.3	75.3
Protein	2.2	1.3
Fat	.1	.6
Total carbohydrate, including fiber	18.0	22.0
Ash	1.0	.8
Calories per lb.	385	460

It is thus seen that considering the edible portion, the banana approximates very closely the potato in analysis and exceeds it by about 20 per cent. in its fuel or food value. Without giving the detailed figures of analyses, it may be of interest to compare the food value of the banana with that of a variety of other foods which we have come to regard as almost indispensable in a properly regulated dietary. The following table from Bulletin No. 28, mentioned above, shows the calorific value per pound of edible portion, except as otherwise noted, of some of these foods, the average result being used in each case for comparison:

Banana	*460*
Spinach	110
Squash	215
Green peas	465
Onions	225
Parsnips	300
Cabbage	145
Green corn	470
Fresh lima beans	570
Beets	215
Macaroni, cooked	415
Boiled oatmeal	285
Asparagus	105
String beans	95
Carrots	210
Clams, raw	240
Lobster	390
Oysters, solids as purchased	230
Scallops	345
Haddock	335
Flounder	290
Halibut, as purchased	470
Bluefish	410
Chicken, broilers, edible portion	505
Pickled tripe	270
Round steak, very lean	540
Round steak, medium fat	950
Milk, whole, as purchased	325
Apples	290
Cherries	365
Figs	380
Grapes	450
Oranges	240

A casual survey of this table shows that the banana exceeds in real food value many foods of different classes which are in almost daily use, such as whole milk, boiled oatmeal, shellfish and other fish, and fresh vegetables. Comparison of the food value of bananas and meats, as for example, round steak, should not be made without calling attention to the fact that the type of food is different in the two classes. Meats are essentially protein foods and as such are more adapted to the development of tissue than to the quick production of heat, while the banana, on the other hand, is less a tissue-forming substance but is incomparably more effective in supplying the heat-giving materials. In a crude way we might say that the proteins are the foods which make good the losses due to wear and tear in the machinery of the body, while the carbohydrates are the foods which keep the machinery in motion and do work. From this standpoint it is seen therefore that the banana, because of its higher carbohydrate content along with a certain amount of protein, would be a more useful all-round food than a pure meat diet in which the amount of carbohydrate is nil. A comparison with medium round steak, for example, shows in the edible portion in each case 65.5 per cent. water for the steak as against 75.3 for the banana, and protein content 20.3 for the meat and a fat of 13.6 per cent. as against the figures for the same constituents of the banana. On the other hand, the meat possesses no carbohydrate, whereas the banana has 22 per cent.

From the standpoint of the consumer the fairest method of comparison between these facts would be in noting the cost in cents per calories of fuel value obtained. At the present market price of meats the advantage is distinctly in favor of the banana. A similar comparison with fish is not without interest. Taking haddock as a food-fish now largely used, we purchase with each pound of fish approximately twelve ounces of water, that is to say, the haddock contains approximately 81 per cent. to 82 per cent. of water as against 75.3 per cent. in the banana. The fish shows a larger proportion of protein, but the fat content, however, is less than in the banana and there is no carbohydrate, wheras, as we have seen, the banana, is rich in this quick-acting, heat-giving substance. From the standpoint of calories, therefore, the banana exceeds the common food-fish considerably and from the standpoint of real costs the odds are greatly in favor of the fruit. If we compare the food value and cost of potatoes and bananas at the present retail price, $1.00 per peck and 25 cents to 30 cents per dozen, respectively, we shall find that of these two substances which are essentially similar in their analyses, there is a decided advantage in favor of the banana. At present prices, April, 1917, when purchasing bananas, one cent will buy 65.9 calories on the average, while in buying potatoes this sum secures 46.6 calories—a 40 per cent. difference in favor of the tropical fruit. In this connection it is perhaps well to call the attention to the fact that the banana can be cooked in a variety of ways and may replace the potato admirably. It may be baked, boiled, fried, served as chips, or "French fried," and in all these ways is an excellent and highly nutritious article of food. For use as a vegetable in the ways just mentioned, it is found of advantage to use fruit which has not reached the state of full-ripeness as the starch content is then greatest and the sugars less, while for desserts and for eating in the natural state the rich sugary fruit is more acceptable.

Bulletin No. 7 of the Bureau of Public Health Education of the New York Dept. of Health, issued February, 1917, says:

> The onion, like most green vegetables, is of value in the diet chiefly for the mineral salts which it contains. It is these and not its protein that make it a valuable addition to bread and meat. Bread and cereals and meat are described by the chemist as having an excess of acid-forming over base-forming mineral matters. Green vegetables and fruits are of the opposite character, having an excess of base-forming minerals. A proper balance of these two classes of minerals in the diet is essential to health. There is danger at the present time, when vegetables are unusually costly, that the health of the community may suffer from a deficiency of base-forming minerals in the diet. It is important, therefore, to call attention to the fact that apples, bananas and oranges, which have not greatly advanced in price, may be used as substitutes for vegetables. They contain the same mineral matters in varying proportions. Apples, bananas and oranges all surpass onions in their excess of base-forming minerals. On Saturday, February 24, a member of the Home Economics department of Hunter College investigated the prices of fruits and vegetables on the upper east side of Manhattan. A few of the prices, with some other facts, are given below:
>
> | | Avg. Cost lb. | Per Cent. Refuse | Avg. Cost per lb. Edible Portion | Food Units per lb. of Edible Portion |
> |---|---|---|---|---|
> | Bananas | $.04 | 35 | $.054 | 460 |
> | Cooking apples | .04 | 25 | .05 | 290 |
> | Small oranges | .05 | 27 | .0635 | 240 |
> | Onions | .15 | 10 | .165 | 220 |
>
> It is therefore evident that these fruits are all cheaper than onions.

It is also clear that on the basis of food value, the banana is nearly a third cheaper.

An analysis made in the laboratory of the writer gave the following results:

ANALYSIS OF BANANA ASH

	Per Cent.
Silica	2.19
Lime	1.82
Iron oxide	0.18
Phosphoric acid	7.68
Magnesia	6.45
Soda	15.11
Potash	43.55
Sulphur trioxide	3.26
Chlorine	7.23

That is, the ash is largely made up of the base-forming salts, the carbonates, phosphates, chlorides and sulphates of potash, soda and magnesia.

Below will be found a table, which has been prepared from analyses shown in Bulletin No. 28, previously referred to, and from the data accumulated by Professor H. C. Sherman, of Columbia University, and other authentic sources, where is shown the analysis of a number of foods both of animal and vegetable origin and their comparative calorific value based on present prices. The costs per pound have been obtained as a result of a number of actual purchases made at retail in New York City and are therefore reliable.

THE NUTRITIVE RATIO

The nutritive ratio shown in the table may require a slight amount of explanation. This is based on the fundamental fact that proteins, carbohydrates and fats supply the actual food material to the body. Of these, protein alone is nitrogenous material, while fats and carbohydrate contain no nitrogen. Nutritive ratio really expresses the relation between the energy derived from the nitrogenous food and that derived from the non-nitrogenous nutrients and is determined by a computation of the calorific value of the proteins as compared with fats and carbohydrates. Since the fats have a heat-giving value which is approximately 2¼ times that of either carbohydrates or protein, the energy relation of nitrogenous to non-nitrogenous material is not an exact expression of the percentages of protein and non-protein, but of the fuel or power-producing value. The figures in the table therefore represent the real amount of energy derived from the total carbohydrate and fat calories as compared with the energy derived from the protein.

In this connection it should be explained, as suggested earlier, that the nitrogenous and non-nitrogenous foods serve somewhat different purposes in the body economy, since the nitrogenous foods are mainly for the repair of tissue, while the non-nitrogenous ones are for the development of power (energy). For this reason it is undesirable and uneconomical to have too much protein. Only the nitrogen actually needed for repair and building of tissue is utilized, the remainder being excreted. There is no storage against a future shortage as in the case of fat. Therefore in a properly balanced diet the amount of protein food should not ordinarily exceed 15 per cent. of the total fuel used. Moreover, the actual amount of fuel used varies with age and occupation. Those doing hard manual labor need more energy and consequently more food. Growing children burn their food rapidly and need more protein in proportion to the total than do adults.

The general relation of foods to the body needs as well as their relative cost based on calorific value is well expressed in the following quotation from the bulletin on "Food: Fuel for the Human Engine," prepared by the recognized expert, Dr. Eugene Lyman Fisk, and issued by the Life Extension Institute of New York during the present year (pp. 5–6)

> There are three main groups of fuel foods: Here they are in order of cost per calorie, *i. e.*, those giving the most energy for the money heading the list.
>
> Starchy Foods
> - Bananas
> - Cornmeal
> - Hominy
> - Broken rice
> - Oatmeal
> - Flour
> - Rice
> - Macaroni
> - Spaghetti
> - Cornstarch
> - Dried lima beans
> - Split peas, yellow
> - Dried navy beans
> - Bread
> - Potatoes
>
> Sugars
> - Sugar
> - Corn syrup
> - Dates
> - Candy
> - Molasses
> - Most Fruits
>
> Fats
> - Drippings
> - Lard
> - Salt Pork
> - Oleomargarine
> - Nutmargarine
> - Peanut butter
> - Milk
> - Bacon
> - Butter
> - Cream
>
> About 85 per cent. of the fuel should come from this group, using starchy foods in largest amounts, fats next and sugars least. Fats, starchy foods and sugars are almost pure fuel, like coal, while cereal foods also contain some building and regulating material.

The same bulletin, presenting a table of the raw materials in common use in the order of their cost per pound, places bananas at the bottom of the list, *i. e.*, the cheapest food.

THE HIGH-POWER FUEL

The banana is not only a higher-power fuel for the body, but it is also rich in the desirable salts. The onion has long been considered a valuable food adjunct because of its mineral salts. The banana is even more valuable.

A little known commodity in America is banana flour, but in view of the shortage of materials it is one which should be seriously considered. The fully grown, but unripe banana, is the source as it is desired to obtain the carbohydrate in the form of starch before it goes over to soluble sugar. The peeled fruit is dried and ground, the water content is removed to approximately 15 per cent. and during this process the other ingredients are concentrated.

According to the eminent English dietetic expert, Dr. Robert Hutchinson in "Food and the Principles of Dietetics," we find:

> The unripe banana is dried and used to produce banana flour or meal. A sample of such a flour had the following percentage composition:

Moisture	Moisture	Proteid	Fat	Carbohydrates	Mineral Matter
Banana flour	13.0	4.0	0.5	80.0	2.5
Wheat flour	13.8	7.9	1.4	76.4	0.5

> I have placed alongside of it the composition of good wheat flour, compared with which the banana meal is rich in carbohydrates and mineral matter, but very poor in proteid. If rice, on the other hand, had been taken for comparison, it would have been found that banana flour was about equal to it in nutritious value.

The *Lancet,* February, 1900, in a discussion of the banana as food says:

> For some reason not yet explained, the starch of the banana is much more digestible than are the cereal starches, besides which the fruit contains a notable proportion of nitrogenous material.

In a later article (*The Lancet,* October 17, 1903), this journal states:

> There can be no doubt of the nutritious character of banana flour, and the starch in it is peculiarly easy of solution and digestion in the alkaline digestive juices of the body. Banana flour is readily dissolved, for example, by the saliva.

Dr. Hutchinson also calls attention in "Food and Dietetics" to the fact that dried bananas compare favorably with dried figs in nutritive value.

During the recent rise in the cost of foodstuffs, Dr. Graham Lusk, at the request of the New York State Board of Health, compiled a low-cost meatless dietary of high efficiency value. In speaking of this he said:

> Potatoes with their valuable alkaline salts had to be excluded from the diet because of their prohibitive price.[1]

It is noted, however, that sliced bananas and sugar appear as a component of luncheon or supper. Many articles have appeared during the past ten years pointing out the high food value and the wholesomeness of this fruit.

The complaint is sometimes made that uncooked bananas are indigestible. Making a careful study of the subject, it is found that this statement is only partly true and should be modified to read that "uncooked, unripe bananas may be indi-

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[1] *Science,* Vol. XLV., April 13, 1917.

Food	Refuse, Per Cent.	Water, Per Cent.	Total Indigestible Nutrients, Per Cent.	Digestible Nutrients			Ash, Per Cent.	Food Value			Avg. Time of Gastric Digestion, Hr. : Min.	Cost per Lb. as Purchased in Cents	Cost per 100 Calories as Purchased in Cents	Calories Purchasable for 5 Cents
				Protein, Per Cent.	Fat, Per Cent.	Carbohydrate, Per Cent.		Per Pound Calories as Purchased	Edible Portion	Nutritive Ratio 1:				
Bananas	35.0	48.9	1.6	.8	.4	14.3	.6	300	460	19.7	1:45	5	1.66	300
Beans, string	7.0	83.0	—	2.1	.3	6.9	.7	180	195	—	3:45	16	8.88	56
Beans, fresh Lima	55.0	30.8	—	3.2	.3	9.9	.8	255	570	—	—	9	3.53	141
Beets	20.0	70.0	—	1.3	.1	7.7	.9	170	215	6.8	3:45	15	8.82	57
Cabbage	15.0	77.7	.6	1.2	.2	4.6	.7	115	135	4.2	4:30	14	12.17	41
Onions	10.0	78.9	—	1.4	.2	6.5	.5	205	215	—	3:30	8	3.90	138
Potatoes, Irish	20.0	62.6	1.2	1.5	.1	14.0	.6	295	370	9.5	2:30	8	2.71	185
Potatoes, sweet	20.0	55.2	1.6	1.2	.5	20.8	.7	460	570	18.3	—	10	2.18	230
Squash	50.0	44.2	.4	.6	.2	4.3	.3	105	215	7.8	—	6	5.71	88
Tomatoes	—	94.3	.5	.7	.4	3.7	.4	95	95	6.6	2:05	15	15.79	32
Beans, dried	—	12.6	7.9	17.5	1.6	57.8	2.6	1,520	1,520	3.5	2:30	20	1.31	380
Apples	25.0	63.3	1.2	.3	.3	9.7	.2	220	290	34.7	1:30	5	2.33	215
Grapes	25.0	58.0	1.7	.9	1.1	13.0	.3	335	450	17.2	—	10	2.98	168
Oranges	27.0	63.4	1.0	.5	.1	7.7	.3	170	240	15.8	—	5	2.64	240
Strawberries	5.0	85.9	1.0	.8	.5	6.3	.5	175	180	9.3	—	20	—	—
Cod (dressed)	29.9	58.5	.5	10.8	.2	—	.6	215	325	0.1	—	10	4.65	108
Flounder	61.5	32.6	—	5.4	.3	—	.5	115	290	—	—	10	8.70	58
Haddock	51.0	40.0	—	8.4	.2	—	.6	165	335	—	1:30	10	6.06	83
Mackerel	44.7	40.4	.7	9.9	4.0	—	.5	365	645	—	—	25	6.85	73
Oysters (solids)	—	88.3	.6	5.8	1.2	3.3	.8	335	335	1.0	2:55	30	8.95	56
Milk, whole	—	87.0	.5	3.2	3.8	5.0	.5	310	310	4.3	3:15	5.5	1.77	282
Eggs, uncooked	11.2	65.5	1.1	12.7	8.8	—	.7	635	720	1.7	—	28	3.90	138
Beef, fresh:														
Round, medium	7.2	60.7	1.4	18.4	12.2	—	.8	890	950	1.5	—	30	3.37	148
Ribs	20.8	43.8	1.8	13.5	20.0	—	.5	1,135	1,433	3.3	—	20	1.76	284
Beef, roasted	—	44.1	—	22.3	28.6	—	1.3	2,805	—	—	4:15	—	—	—
Beef, dried and roasted	4.7	53.7	4.5	25.6	6.6	—	5.5	790	840	0.6	—	16	2.03	221
Beef, boiled and salted	—	38.1	—	26.2	34.9	—	.9	1,620	—	—	3:20	—	—	—
Corned rump	6.0	54.5	—	14.3	22.0	—	3.1	1,195	1,270	—	—	30	2.51	199
Veal cutlets	3.4	68.3	1.2	19.5	7.1	—	.8	690	705	0.8	5:00	22	3.66	137
Mutton, hind quarter	17.2	45.4	—	13.8	23.2	—	.7	1,235	1,495	—	3:00	25	2.02	247
Lamb, hind quarter	15.7	51.3	—	16.5	16.1	—	.9	985	1,170	—	—	26	2.47	202
Ham, smoked	14.0	34.8	—	14.2	33.4	—	4.2	1,675	1,940	—	—	30	1.79	279
Bread, white	—	35.3	2.9	7.8	1.2	52.0	.8	1,200	1,200	7.0	3:30	16	1.33	376

The outstanding fact that at once impresses the careful student of these and similar figures is that dried beans and bread alone are cheaper than the banana when measured in fuel value. The banana to-day provides more actual food for the same cost than any fresh fruit or vegetable, or fish, meat, milk or eggs.

gestible," for all evidence shows that the thoroughly ripened banana is not only digestible, but it is one of the easiest foods to digest in the whole dietary. Dr. Arnold Lorand of Carlsbad states that "as far as their digestibility is concerned I have personally noted that when eating a perfectly ripe banana it almost melts in the mouth when simply turned over several times without any actual mastication and only a few stringy fibers in the middle of the fruit will remain. In this way two or three large bananas may be eaten without there being any feeling of discomfort in the stomach. Of course bananas are only thus digestible when quite ripe; those still somewhat green are less so, especially when they feel hard on the outside, although when very well masticated they are easily dissolved." As a matter of fact, many people assume that when a banana begins to show brown or black spots on the skin it is past the period of ripeness, whereas it is approaching the point when it may be regarded as perfectly ripe.

Comparative studies on the length of time required for foods entering the stomach to be digested and passed on to the intestinal tract, have been published by numerous investigators. One which has stood the test of time shows the following figures:

Foods	Average time of digestion. hr. min.
Ripe bananas	1.45
Oatmeal	3.5
Beans	2.30
Cabbage	4.30
Onions	2.5
Green peas	2.35
Boiled potatoes	3.30
Tomatoes	2.5
Turnips	4.0
Vegetable marrow	1.45
Boiled beef	4.15
Roast beef	3.20
Roast mutton	3.15
Roast pork	5.20
Soft boiled eggs	3.30
Boiled fowl	3.0
Codfish	3.30
Mackerel	4.0
Apples	2.30
Nuts	4.0
Oranges	2.45
Plums	3.40

This table shows that of all these common foods the banana is the most readily digested. This is explainable by the fact which was previously mentioned, that in the mouth during the process of mastication the carbohydrate is largely transformed into assimilable sugar and the further process of transformation in the stomach requires but a relatively short time. A meal of steak and potatoes would be seen, according to the table given, to occupy approximately three and one half hours for the digestive changes of the mouth and stomach to take place, whereas the ripe banana fruit would be digested and ready for absorption in half that time. It has already been shown that the banana is actually richer in nutrients per pound of material than the common food-fish or the common food vegetables. The table just cited above shows that it also is a more easily digested food than fish or vegetables, requiring a shorter time period for the digestive fluids to act in order to bring it into usable form.

General Conclusions

The statements which have preceded should not fail to make it clear that in a period like the present when we are facing a general shortage of cereal and other carbohydrate food we may turn to the banana as one possible solution of our difficulty. The fact that bananas may be obtained in abundance throughout the year, that they may be shipped for long distances under suitable conditions without being impaired in any way, that they may be used either as a fruit or as a vegetable, cooked or raw, in their normal form or dried or powdered, shows clearly that in this remarkable fruit we have an adjunct to our dietary which should not be underestimated. Used in connection with dried beans or peas or with dairy products such as milk and cheese or with the lean meat, it serves perfectly to secure a properly balanced ration.

It is practically the only food which during the last two years has not shown a marked increase in price and to-day will stand comparison with any food upon the market on the basis of caloric costs. Everything points to its continued favor not merely as the "poor man's fruit" as it has sometimes been called, but as a staple food for universal use, and it is to be hoped that it will be employed in continually increasing amounts whether as a substitute for other foods which have become prohibitive in price or because of its own inherent quality.